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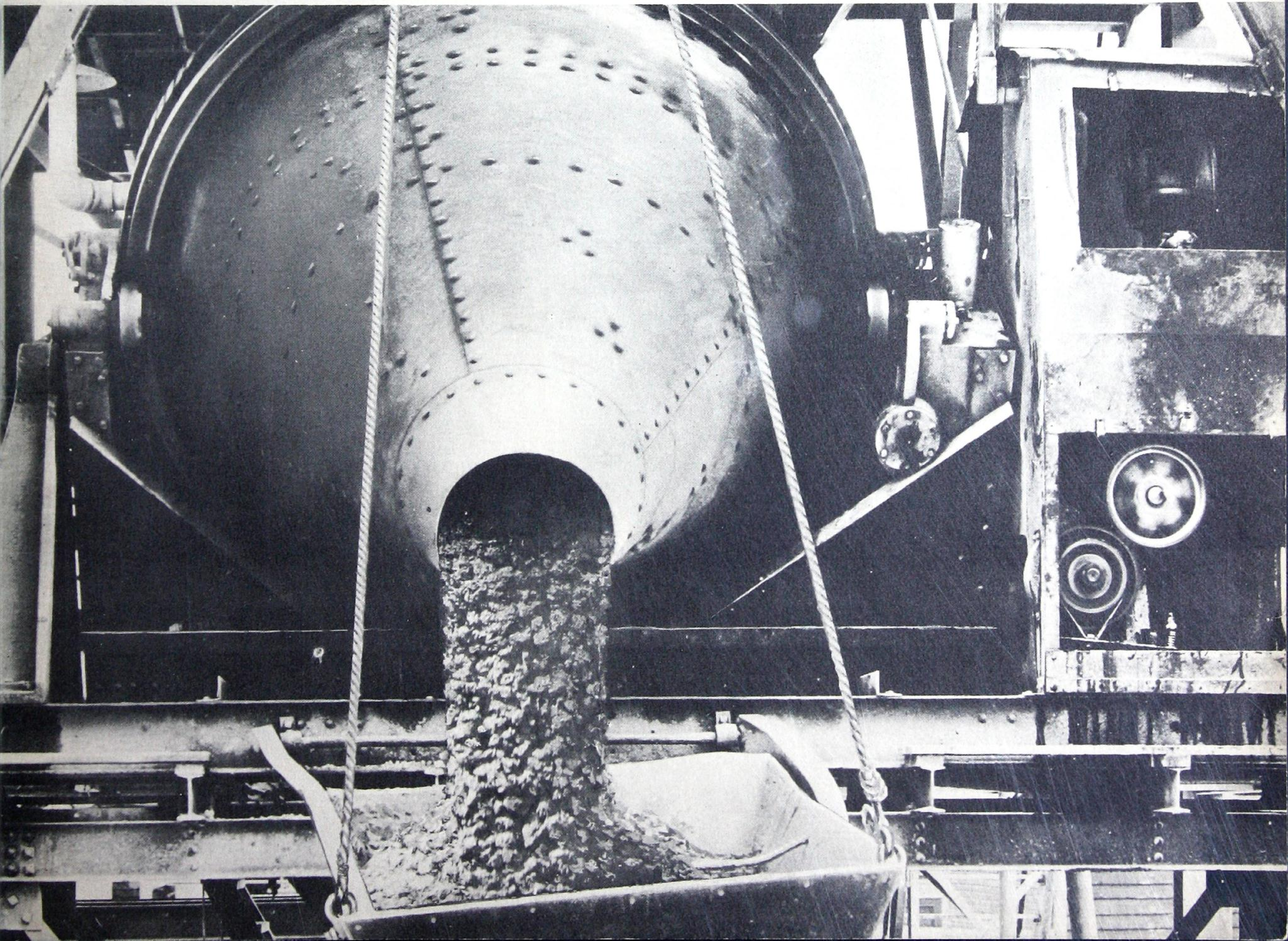
Watertight Concrete

with 'INCOR' 24-Hour Cement



'INCOR' 24-HOUR CEMENT IS MADE BY THE PRODUCERS OF LONE STAR CEMENT:

Lone Star Cement Company Alabama	Birmingham
Lone Star Cement Company Indiana, Inc.	Indianapolis
The Lone Star Cement Company (Kansas)	Kansas City, Mo.
Lone Star Cement Company Louisiana	New Orleans
Lone Star Cement Company New York, Inc.	New York-Albany
Lone Star Cement Company Pennsylvania	New York-Nazareth
Lone Star Cement Company Texas	Dallas-Houston
Lone Star Cement Company Virginia, Inc.	Norfolk
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Watertight Concrete

How to obtain Watertight Concrete . . . Thorough curing essential . . . Why 'Incor' Cement produces better concrete at a substantial saving in curing cost.

FOREWORD

Good concrete is inherently watertight—poor concrete is not. Surface treatments or waterproofing compounds are of little value, unless concrete is made of good materials and properly mixed, placed and cured; possessing these qualities, concrete has of itself all necessary watertight characteristics. Innumerable structures which keep water out or in, without leakage or seepage, clearly demonstrate the natural watertight qualities of well-made concrete.

Watertight concrete is obtained by mixing proper proportions of cement and water with good sand and stone; placing the concrete without segregation, and curing it thoroughly. A well-made concrete, carefully placed, will be watertight or not, depending on how well it is cured.

Curing, that is, keeping the concrete wet, cannot go on indefinitely; it costs money, interferes with the use of the structure. *The best concrete is that which cures thoroughly during the short time it is kept wet.*

Because it combines more rapidly with water, 'Incor' 24-Hour Cement cures or hardens faster. One day's curing with 'Incor' is equal to at least three days curing with ordinary portland cement, two days with 'Incor' equals ten days with ordinary cement, three days equals two weeks, and so on.

By curing more thoroughly in the limited time available on the average job, 'Incor' makes concrete that is stronger, denser, and more watertight.

In addition, 'Incor's' inherent plasticity produces more workable concrete, assures a more uniform and cohesive mass; aggregates are held firmly in suspension, reducing segregation.

'Incor' is a better, more thoroughly processed Portland cement. Follow sound concrete practice to obtain the advantages resulting from its dependable high early strength.

SELECTING THE MIX

THE quantity of mixing water per sack of cement is governed by the service to which the concrete is to be put. There are two factors to take into account; first, durability,—that is the concrete's resistance to weather, wear or destructive agents encountered in service; second,—the strength needed to meet the structural requirements.

First, determine the quantity of water, based on required durability

Table I gives proper water quantities for various types of structures and degrees of exposure. These recommendations are based on average conditions and assume proper workability of the mixture, thorough mixing, placing the concrete without segregation,—that is, without separation of coarse aggregate from mortar,—and thorough protection from drying out or from low temperature during the early hardening period. *For watertight concrete, the maximum quantities of water shown in this Table must not be exceeded.*

Next, determine the quantity of water to meet strength requirements

Consideration must also be given to the strength needed in a given period of time, in order to meet design requirements. This can readily be determined by the quantity of mixing water indicated in Fig. 1-a for ordinary cement and in Fig. 1-b for 'Incor'* 24-Hour Cement. These values are based on maintenance of 70° temperature and complete moist curing; allowance must be made for lower temperatures and less efficient curing.

For example, assume that a water tank is to be erected out-of-doors in a northern state. For durability, not more than 6 gallons of water must be used per sack of cement. (See Table I, item 3, col. 2). The structural design requires 3000-pound concrete when placed in service. The tank may be filled in 7 days, if not more than 5¾ gallons of water are used with ordinary Portland cement. (See Fig. 1-a). With 'Incor,' 6 gallons of water is found to produce sufficient strength to meet the

TABLE I. WATER CONTENT FOR VARIOUS EXPOSURES

This table is based upon the use of cement meeting standard specifications. Moist cured at normal temperatures for 10 days using ordinary Portland cement and 2 days using 'Incor' Cement. (Water or moisture in aggregate must be included as part of mixing water.)

EXPOSURE / CLASS OF STRUCTURE	MIXING WATER, U. S. GAL. PER SACK OF CEMENT		
	Piles, thin walls and light structural members. Exterior columns and beams	*Reservoirs, water tanks, pressure pipes, sewers, canal linings, dams of thin sections*	*Heavy walls, piers, foundations, dams of heavy sections*
Extreme: 1. Northern U. S., subject to alternate freezing and thawing, wetting and drying. 2. Sea water and strong sulphate waters, in both severe and moderate climates.	5½	5½	6
Severe: 3. Northern U. S., exposure to rain, snow, freezing and thawing, but not alternate wetting and drying. 4. Southern U. S., alternate freezing and thawing.	6	6	6¾
Moderate: 5. Southern U. S., ordinary weather exposure. 6. Completely submerged in water but protected from freezing.	6¾	6	7½
Protected: 7. Interior structural members; concrete below ground level, not subject to corrosive ground waters or freezing and thawing.	7½	6	8¼

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*Reg. U. S. Pat. Off.

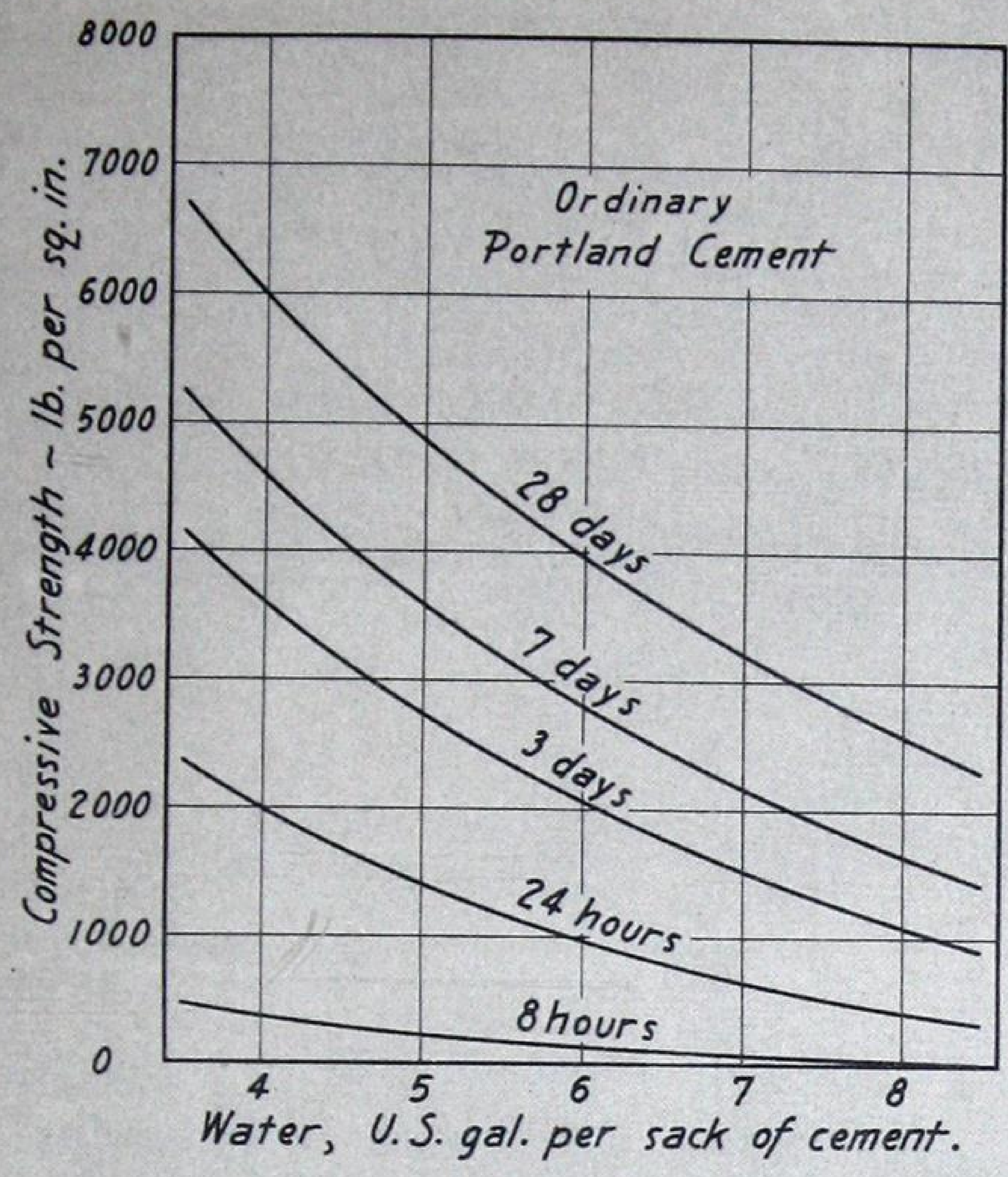


Fig. 1-a—Ordinary Portland Cement

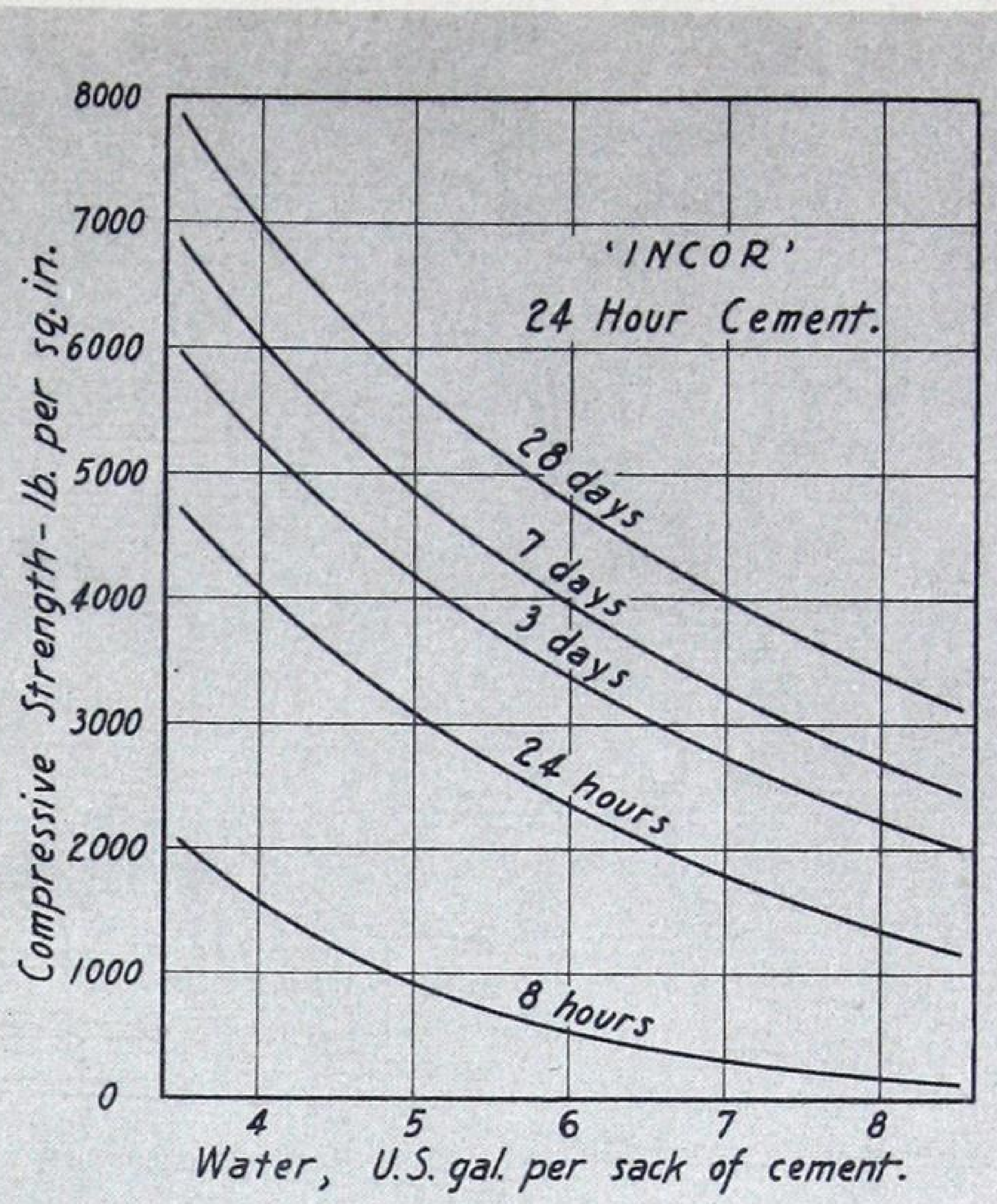


Fig. 1-b—'Incor' 24-Hour Cement

Concrete strengths decrease as water content increases. For ordinary Portland cement (see Fig. 1-a), 6 gal. of water will produce 2,800 lbs. strength at 7 days and 4,000 lbs. at 28 days. If water is increased to 8 gal., strengths are reduced to 1,700 lbs. and 2,500 lbs., respectively.

The same holds true with 'Incor' Cement (see Fig. 1-b), except that strengths obtained are considerably higher. Thus, 6 gal. of mixing water will produce 2,300 lbs. strength at one day, 3,900 lbs. at 7 days and 4,800 lbs. at 28 days. If water is increased to 8 gal., strengths are reduced to 1,400 lbs., 2,700 lbs. and 3,500 lbs., respectively.

The strengths shown are based on tests of 6 x 12" cylinders, cured moist until tested. Under job conditions, make allowance for variations in temperature and curing.

NOTE: Reduce the amount of mixing water by ½ gal. if the sand is damp, or by 1 gal. if the sand is wet.

requirements in 3 days. (See Fig. 1-b).

To produce watertight concrete, the maximum quantity of water selected must not be exceeded. The importance of this cannot be over-emphasized. Too much water weakens the concrete. It also leaves in the hardened concrete innumerable void-spaces which may cause leakage. *To assure watertightness, these voids or pores must be small and unconnected. If too much water is used or the curing period is insufficient, the watertightness and durability of the concrete are seriously impaired.*

Next, select the consistency required for a given type of job

It is necessary to consider the conditions to be met in handling and placing the concrete. This includes the means for moving the concrete from the mixer into place, as well as the size and shape of the space to be filled, spacing of reinforcing rods and other similar details. For example, a stiff mixture with large aggregates, which is workable in a large open form, would not be workable in a thin wall or between closely-spaced reinforcing bars or in a floor slab.

The concrete must be readily workable under the method of handling and placing to be used. If the concrete is to be spaded and puddled by hand, greater workability is necessary than if it is to be compacted by a mechanical device such as a vibrator.

A wet mix will tend to segregate in handling; if it is too dry it cannot be properly compacted into a dense mass free from void spaces. Here the smooth working qualities of 'Incor' are of great value. An 'Incor' mix clings together, minimizing segregation; it is also easily workable, greatly aiding placing.

The most convenient means for measuring the workability of concrete is the slump test; this test is illustrated in Fig. 2, left-hand column. The most accurate method for making this test is with the slump cone. Where apparatus for making this test is not available, workability can be measured on the job by using a bucket, as also shown in Fig. 2, right-hand column.

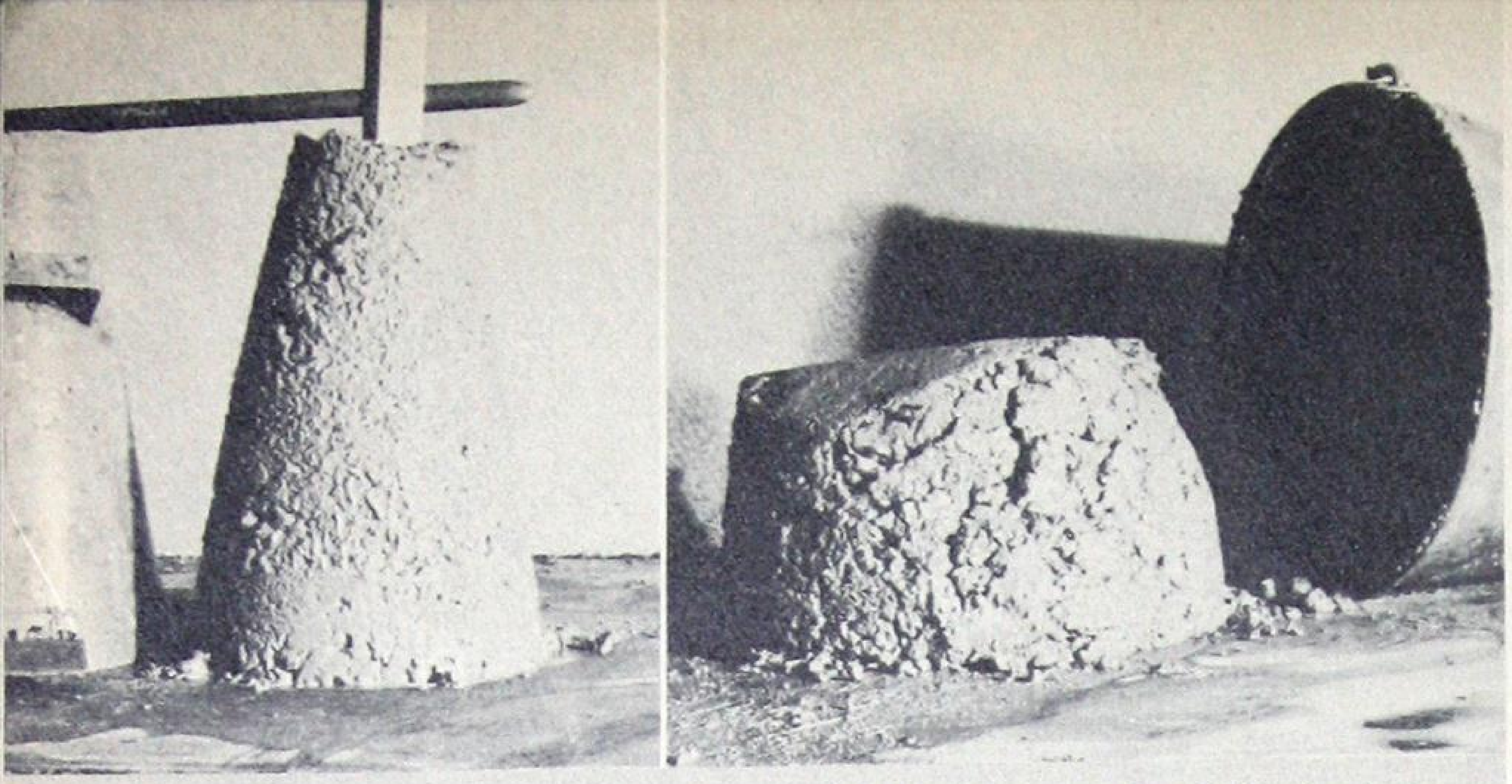


Fig. 2-a: This concrete has a slump of slightly less than 1 inch. A very dry concrete is difficult to place by hand, but is suitable for placing by mechanical means, such as vibrator or roller.

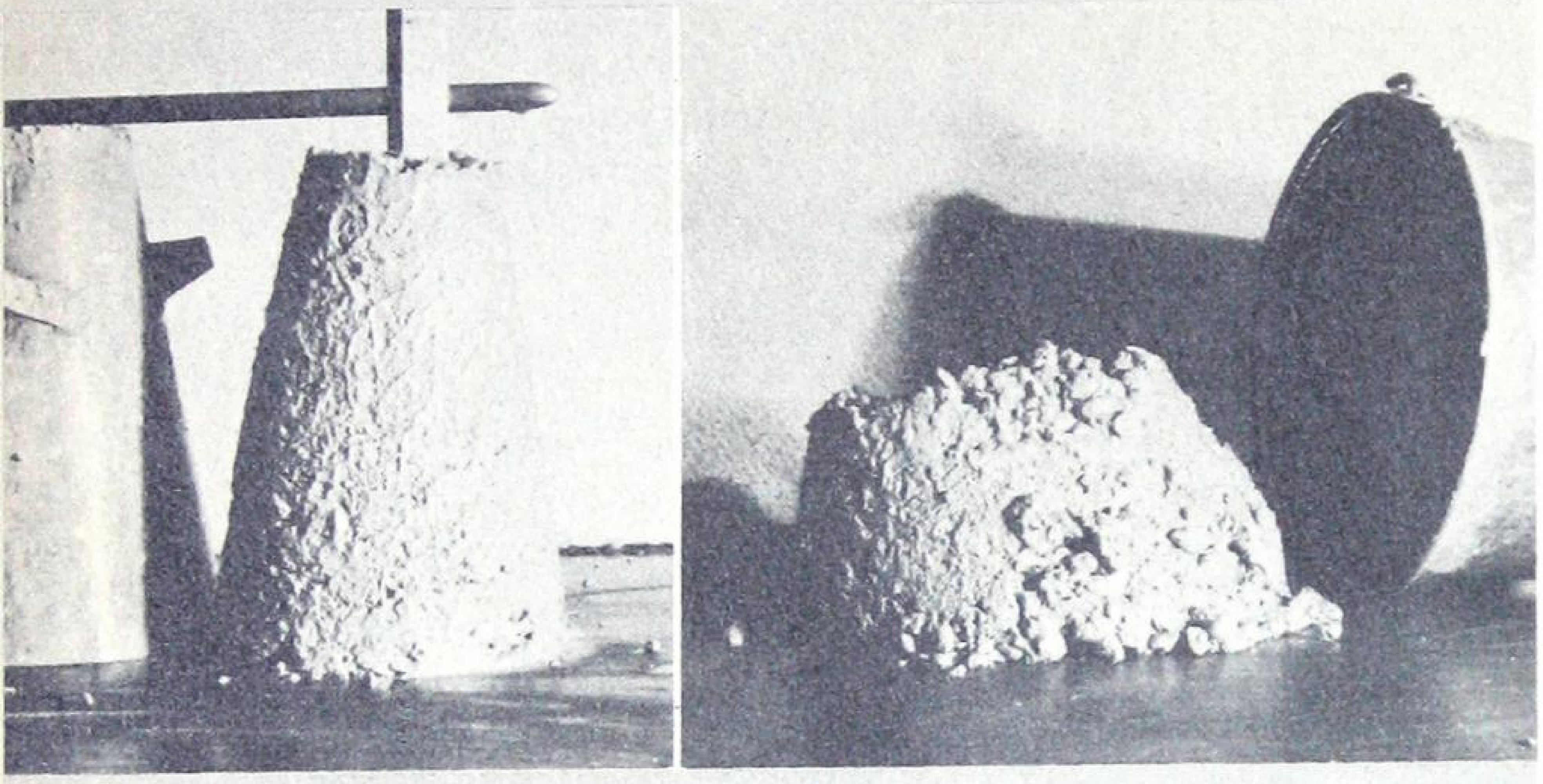


Fig. 2-b: This concrete has a slump of 2 inches. It will place without segregation and finish readily. It is suitable for use in pavements, floors and in mass concrete.

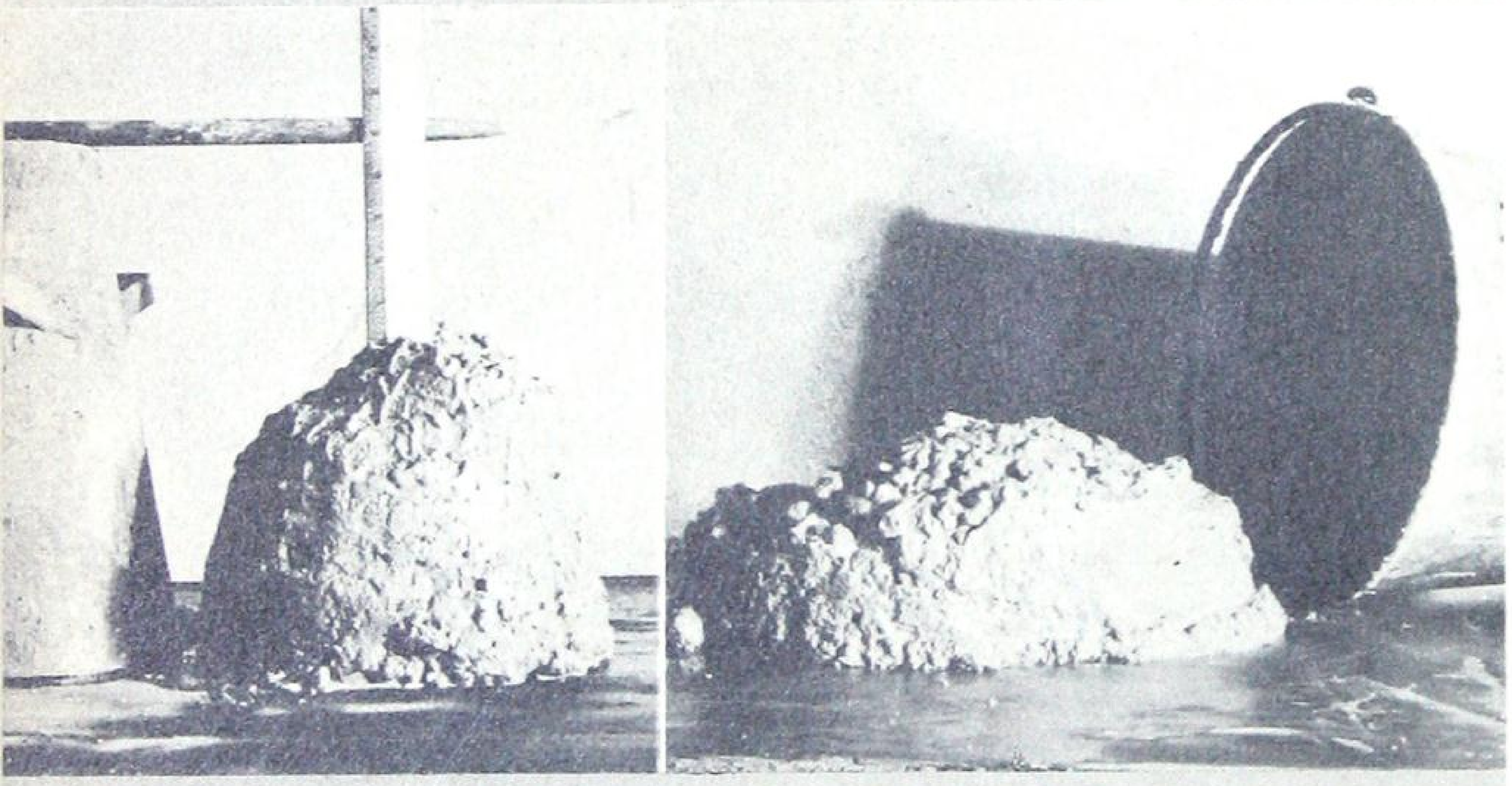


Fig. 2-c: This concrete has a slump of 5 inches. It will place readily around reinforcing bars in girders and columns, with slight spading.

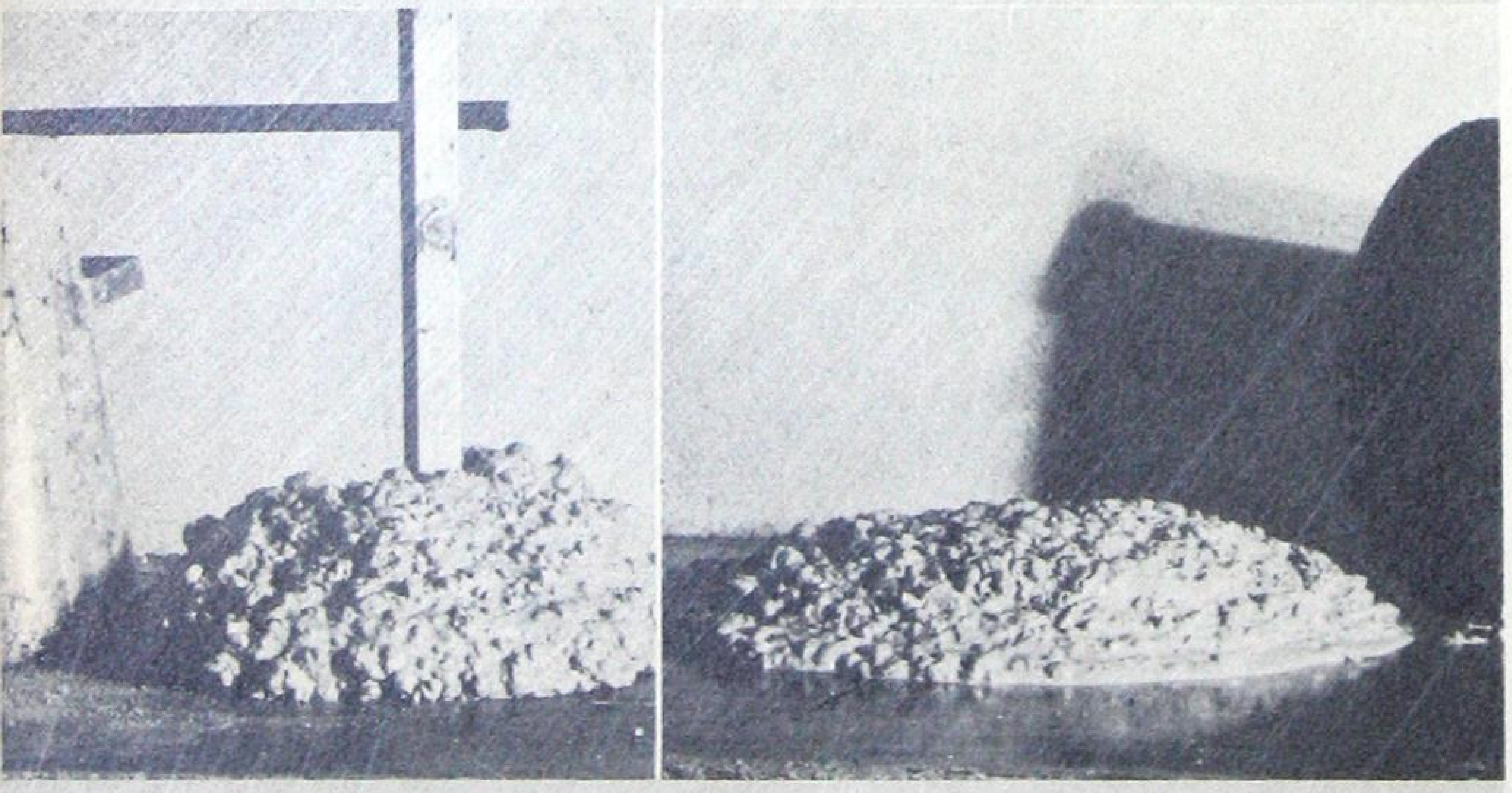


Fig. 2-d: This concrete has a slump of 8 inches. Slumps of over 6 inches are beyond the range of watertight concrete, because of separation and resulting lack of uniformity in the concrete.

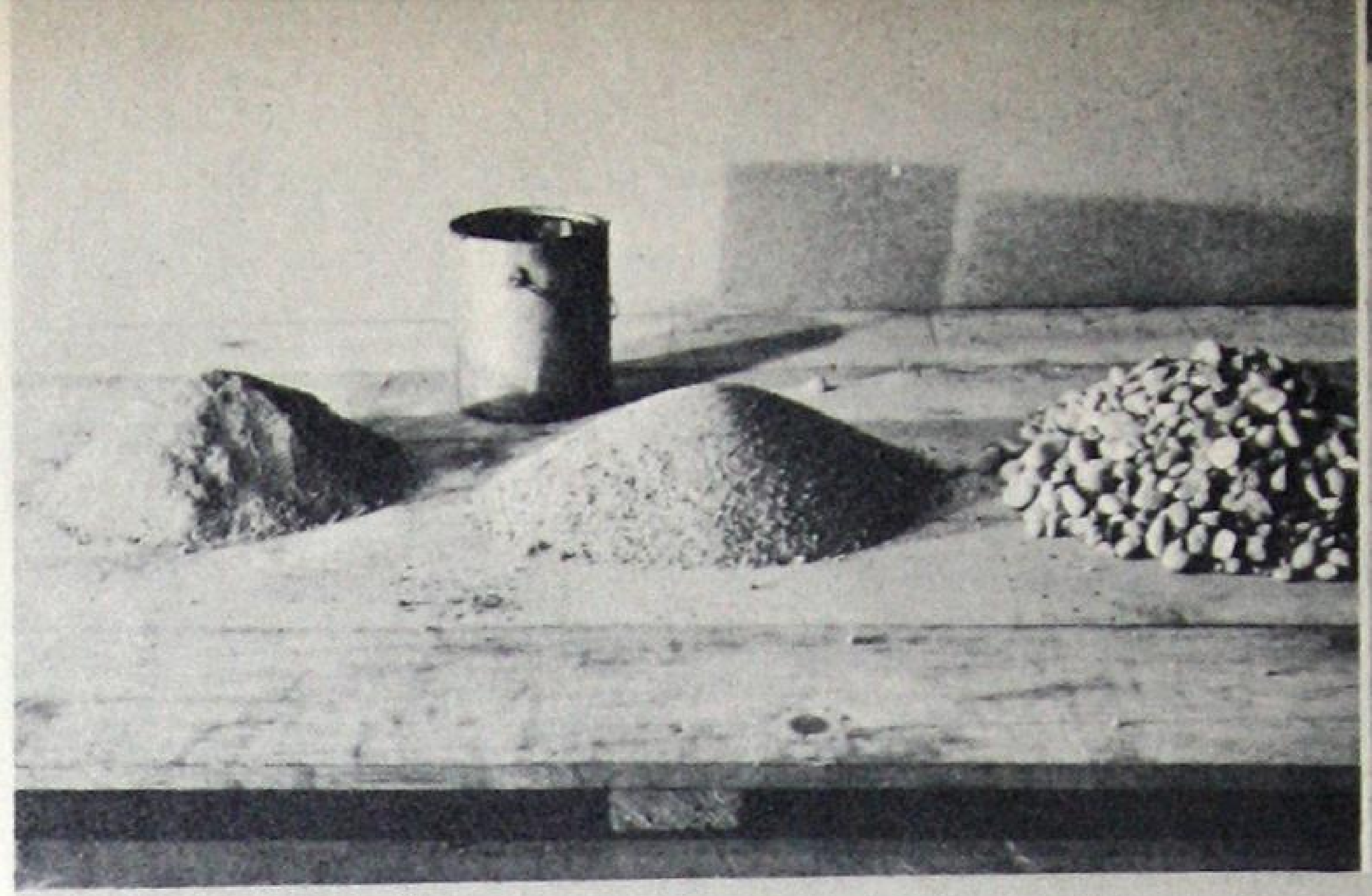


Fig. 5-a: Weigh cement, sand, gravel and water for trial batch.

Fig. 5-b: M
tained; pile

Quantity of Aggregates

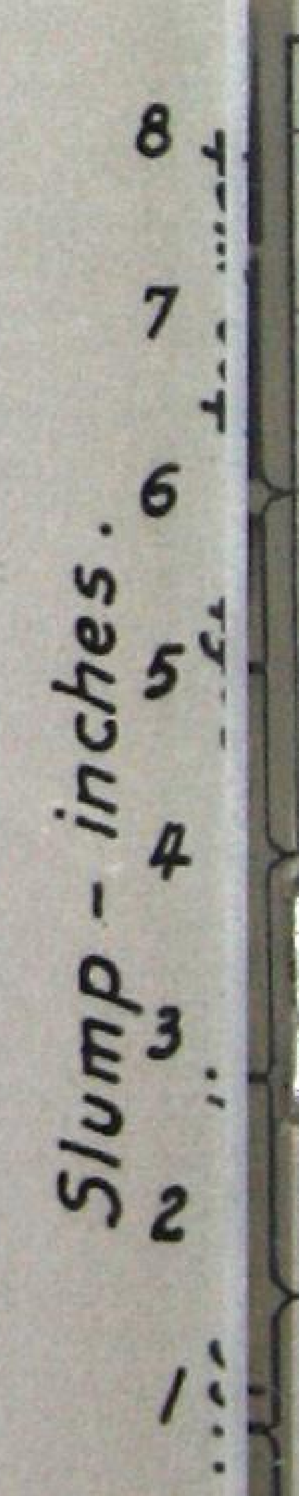
The next step is to determine the approximate quantity of aggregates by reference to Fig. 3. The quantity of aggregates which a concrete can carry without sacrificing workability depends upon the grading and the size, shape and porosity of the individual particles. This graph is based upon average conditions; readings should be modified to meet the characteristics of local aggregates and in the light of trial batches.

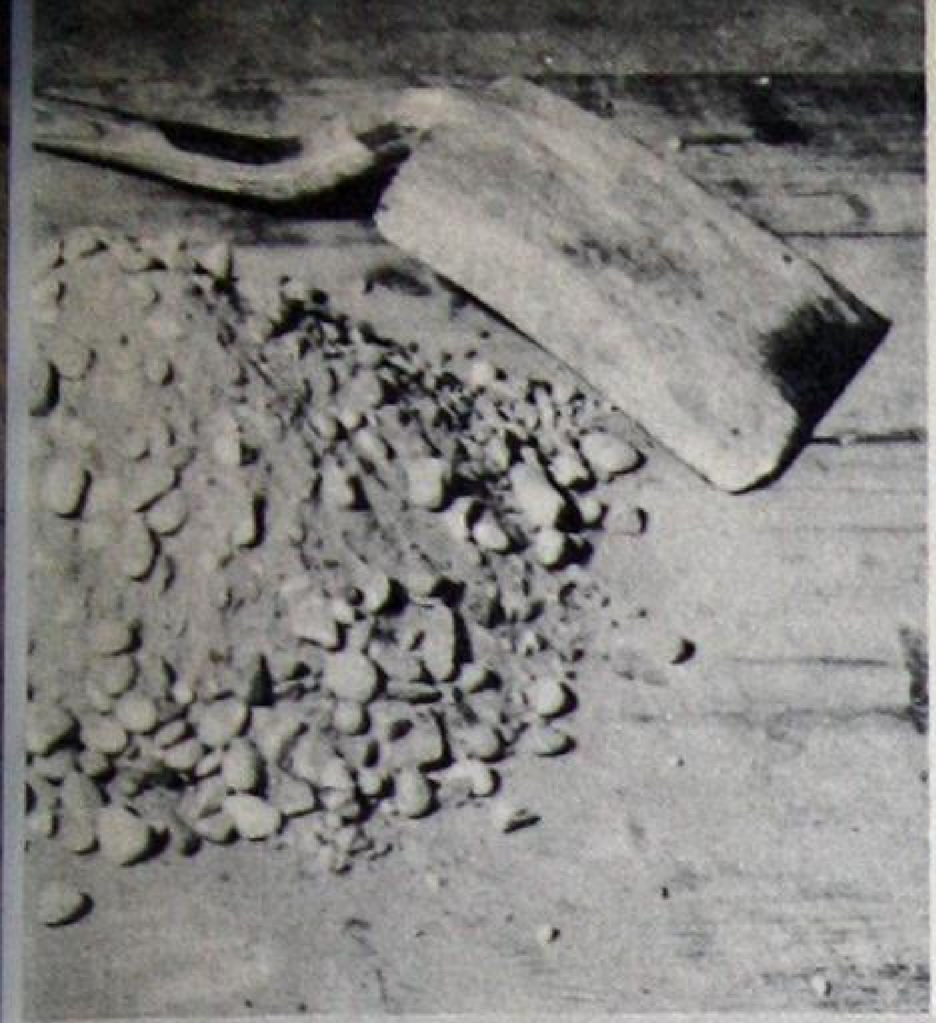
The proper amount of sand generally varies between 30% and 40% of the total weight of the combined fine and coarse aggregate. Varying amounts of sand affect the slump, workability and watertightness, as shown in Fig. 4. Trial batches are the best way to find out what the proportions should be with a given aggregate.

Mix trial batches to determine the proper proportion of sand

The effect of varying sand proportions is shown in Fig. 4. Concretes suitable for hand placing carry too

Fig. 3: Select the proper slump from photographs in Fig, 2 or from experience. Find this slump at left of chart; then follow horizontal line to right until it intersects required water content (as determined from Table I). From that point proceed vertically to bottom of graph, to find approximate total quantity of aggregate which will produce desired slump or workability. An increase in slump decreases the quantity of aggregate which may be used. Thus, a 2-inch slump, using 6 gal. of water, permits use of 625 lbs. of aggregate per bag of cement, while a 6-inch slump with same water content reduces quantity of aggregate to 510 lbs.





until uniform mixture is ob-
cone.

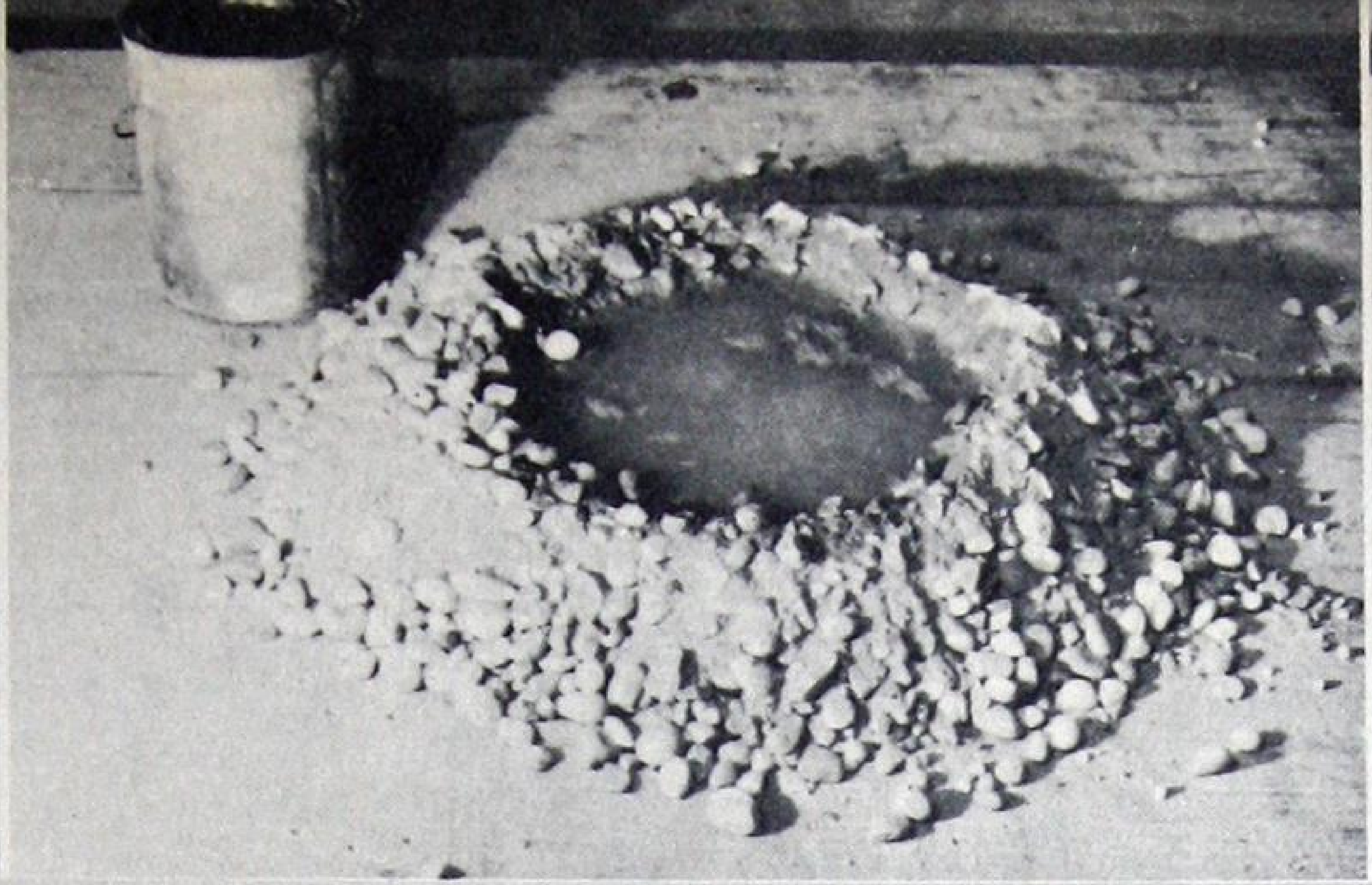


Fig. 5-c: Form a crater; add measured quantity of water; mix wet.

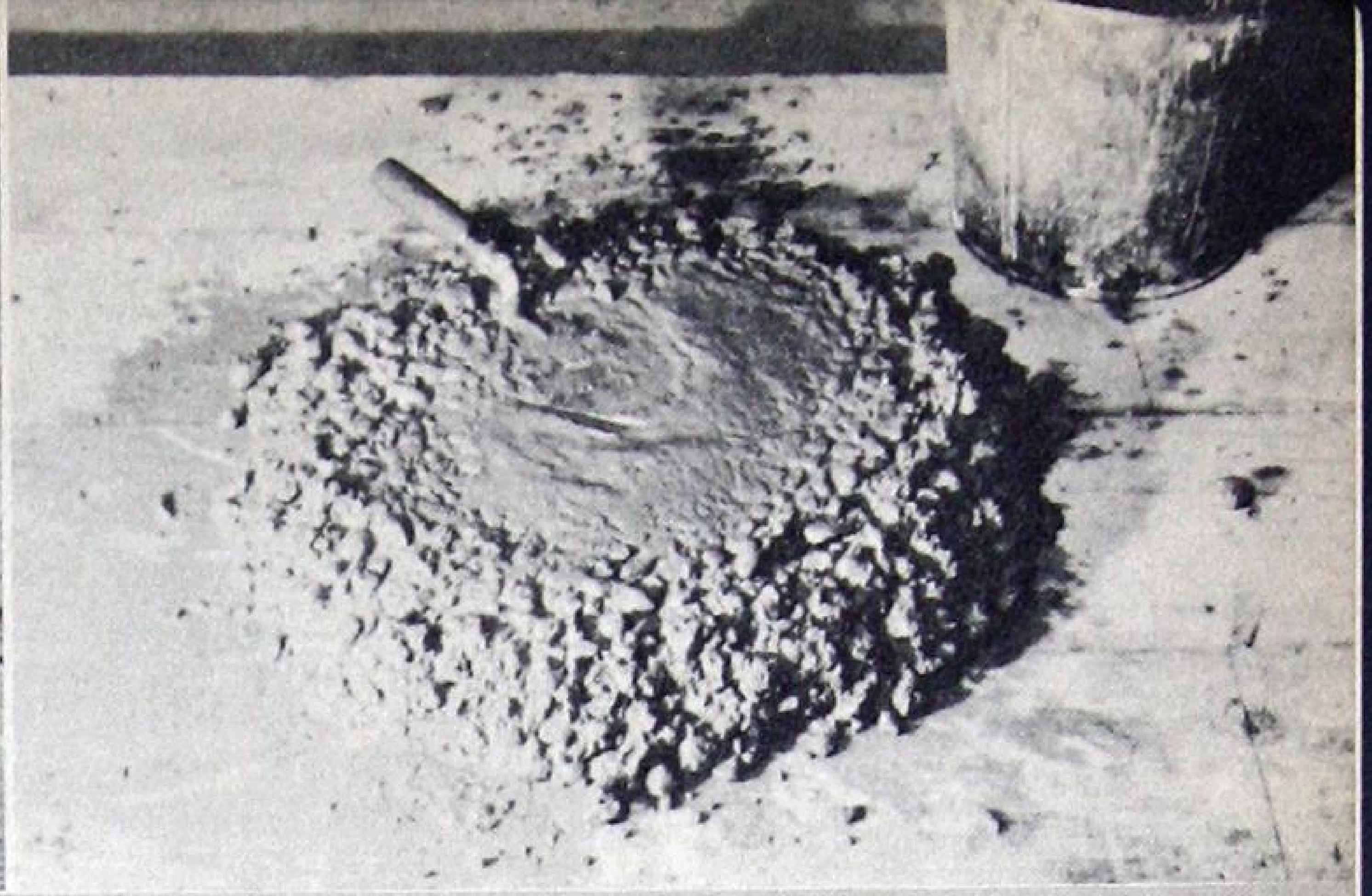
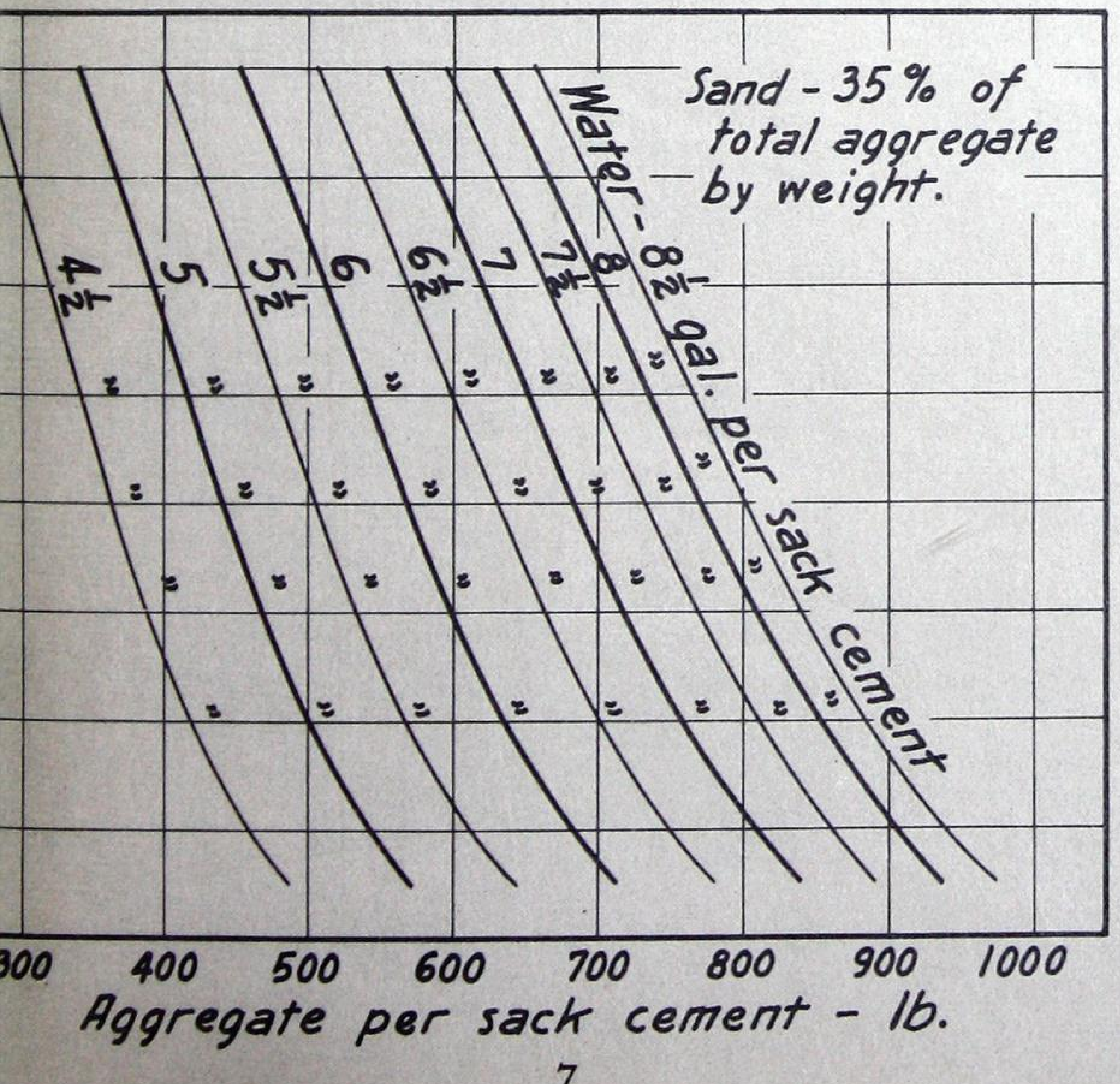


Fig. 5-d: Mix until mass is uniform; determine workability by bucket, slump or trowel test.

much sand for placing by mechanical means. While sand improves workability, oversanding must be avoided, as it adversely affects watertightness. Make several trial batches in order to determine the proper amount of sand for the desired workability. Assume that 35% of the total aggregate, determined from Fig. 3, will be sand. Make up a batch of concrete using 1/10-bag of cement, which is 9.4 lbs. and 1/10 of the weight of aggregate determined from Fig. 3. For example, if 600 lbs. is the correct amount of aggregate, use 60 lbs. in the trial batch; 35% or 21 lbs. of this will then be sand and 39 lbs. coarse aggregate. If 6 gallons of water per bag is the required amount, use 1/10 of 6 gallons (6 x 8⅓ lbs. =50 lbs.) or 5 lbs. of water for the trial batch.

All that is required for these measurements is a scale having a capacity of 50 lbs., containers for weighing aggregates, cement and water, and a non-absorbent surface on which to mix the concrete. Fig. 5 shows the simple steps in mixing trial batches. If volume propor-



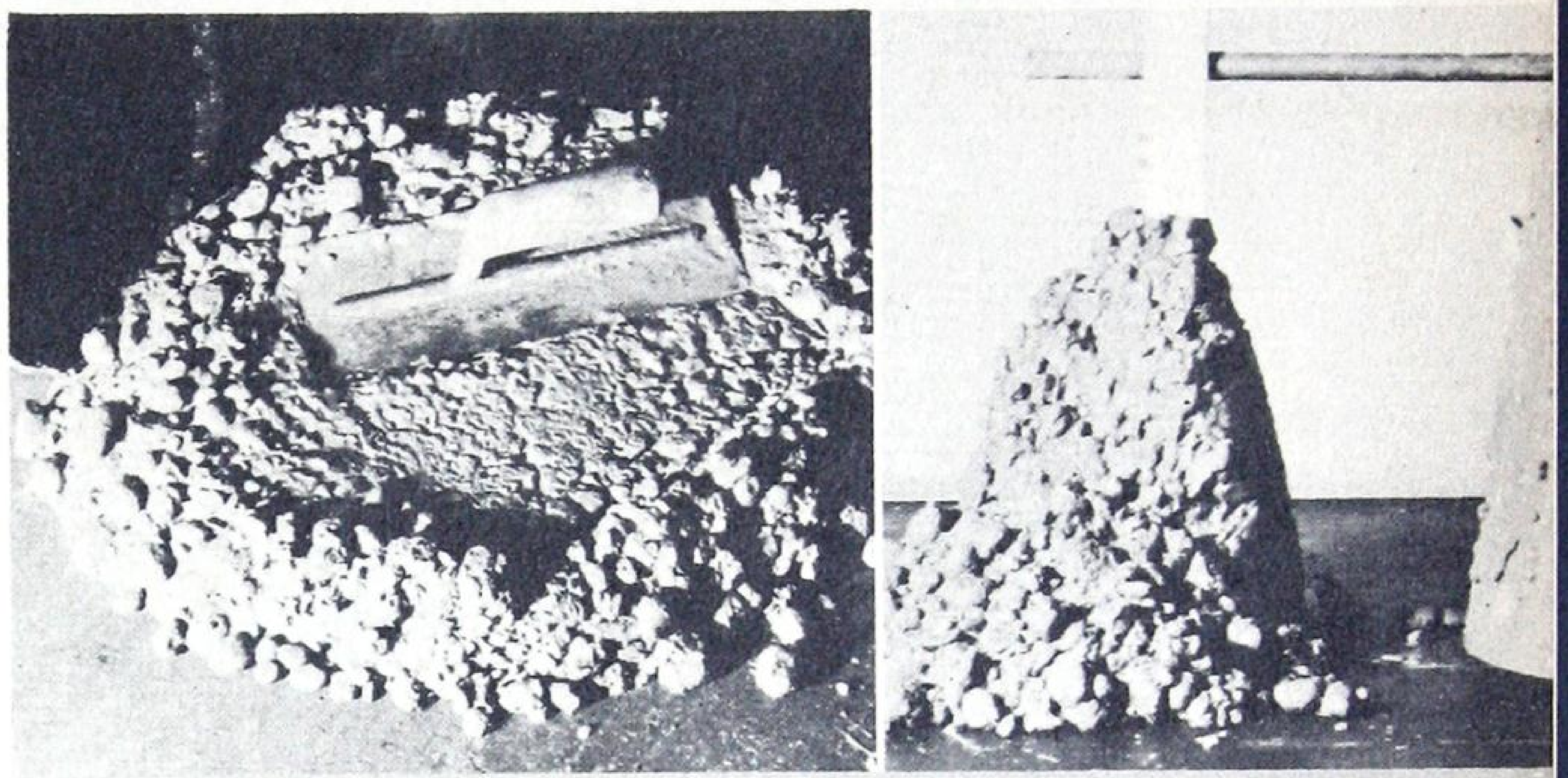


Fig. 4-a: This concrete contains 30% sand. It is somewhat harsh and requires considerable spading. For mechanical placing, the sand content could be as low as 25%.

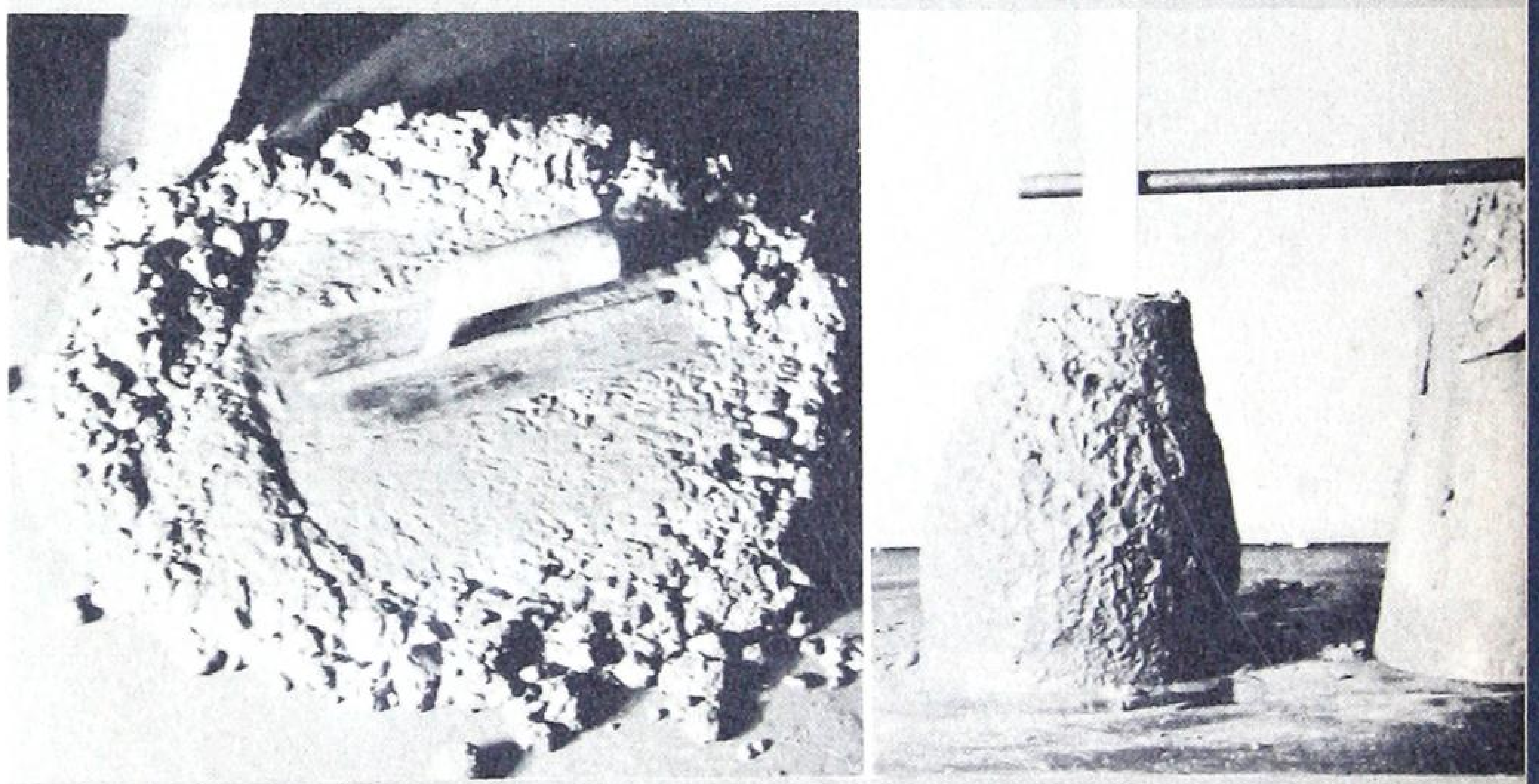


Fig. 4-b: This concrete contains 36% sand. It has about the right sand content for hand placing with slight rodding and spading.

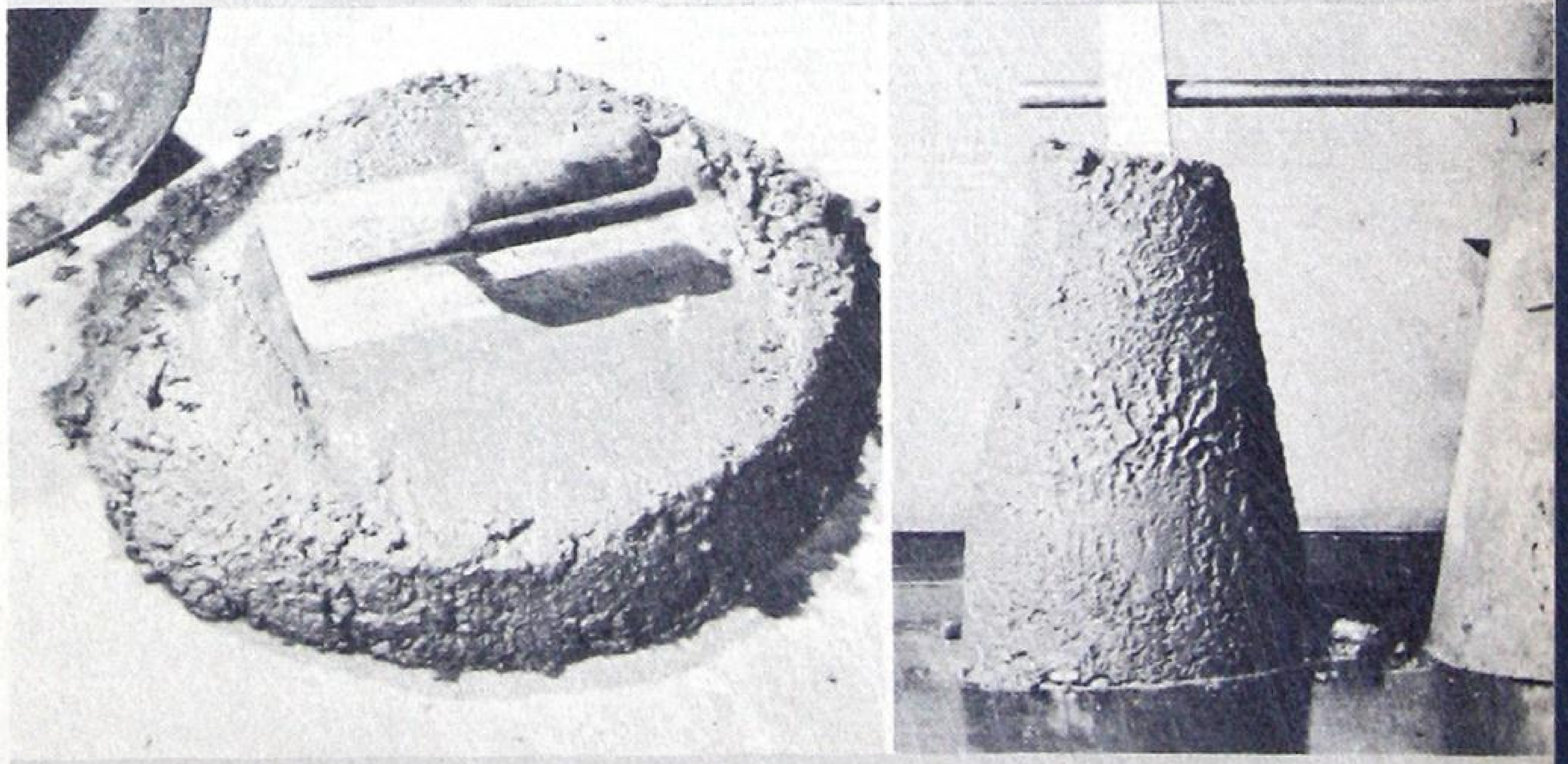


Fig. 4-c: This concrete contains 44% sand. It is over-sanded, tending to produce concrete with many small void-spaces, reducing its watertightness. Note how the slump decreases as the sand content increases; the more sand the stiffer the mix.

tions are to be used, mark measuring boxes to show the volume of sand and stone required for the size batch employed. These markings should be checked against weights from time to time to insure accuracy.

Cost Factors

As aggregates are usually less expensive than cement, the maximum quantity of aggregates should be used. At the same time, workability must not be sacrificed,—first, because the less workable the concrete, the more it costs to place it properly; and secondly, because insufficient workability invariably results in the addition of more water at the job. This extra water impairs the strength, durability and watertightness of the concrete, increases segregation and reduces density.

With the same amount of water per bag of cement, a 1-inch slump concrete will carry 25% to 50% more aggregate than a concrete having an 8-inch slump. Therefore, the quantity of aggregate to be used should be based upon the maximum economy in the combined cost of materials and placing.

Quality of Aggregates

Only well-graded, clean aggregates should be used. Established commercial producers who wash and grade the materials can generally be depended upon to furnish high-grade aggregates. This is particularly true if the Federal Government, State Highway Departments or railroad engineers have approved the materials for use in their work. Unproven materials should not be used in important work unless an examination is first made by a competent engineer.

MIXING AND PLACING

To insure uniformity and increase workability, concrete should be mixed at least 1½ minutes after all materials have been placed in the mixer. (See Fig. 6).

Concrete should be transported directly from mixer to forms, in a manner that avoids segregation. Before placing the concrete, forms should be thoroughly cleaned and oiled. Temporary openings in the forms should be provided where necessary, to facilitate cleaning and inspection. These should be so placed that excess water used in flushing forms may be drained out.

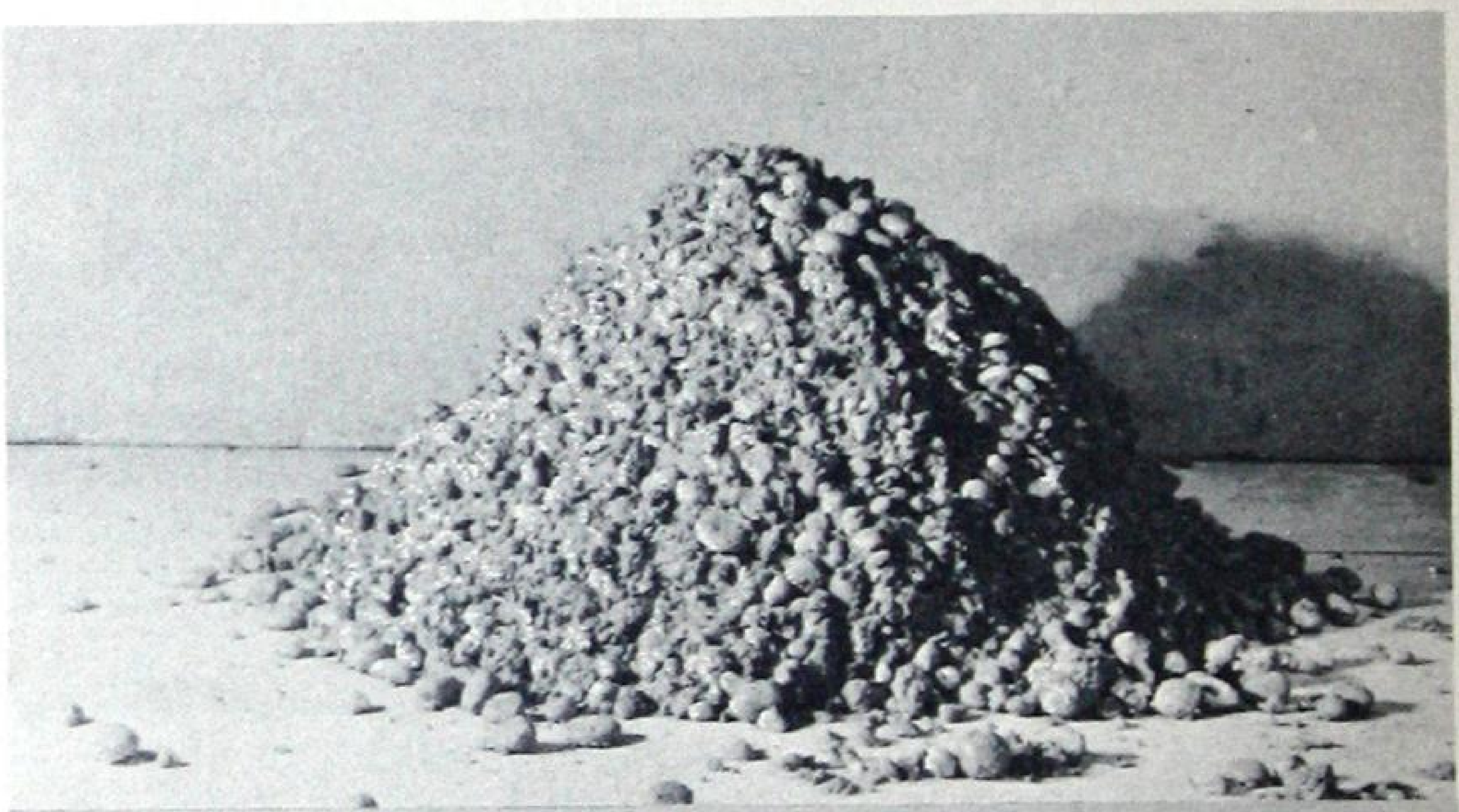
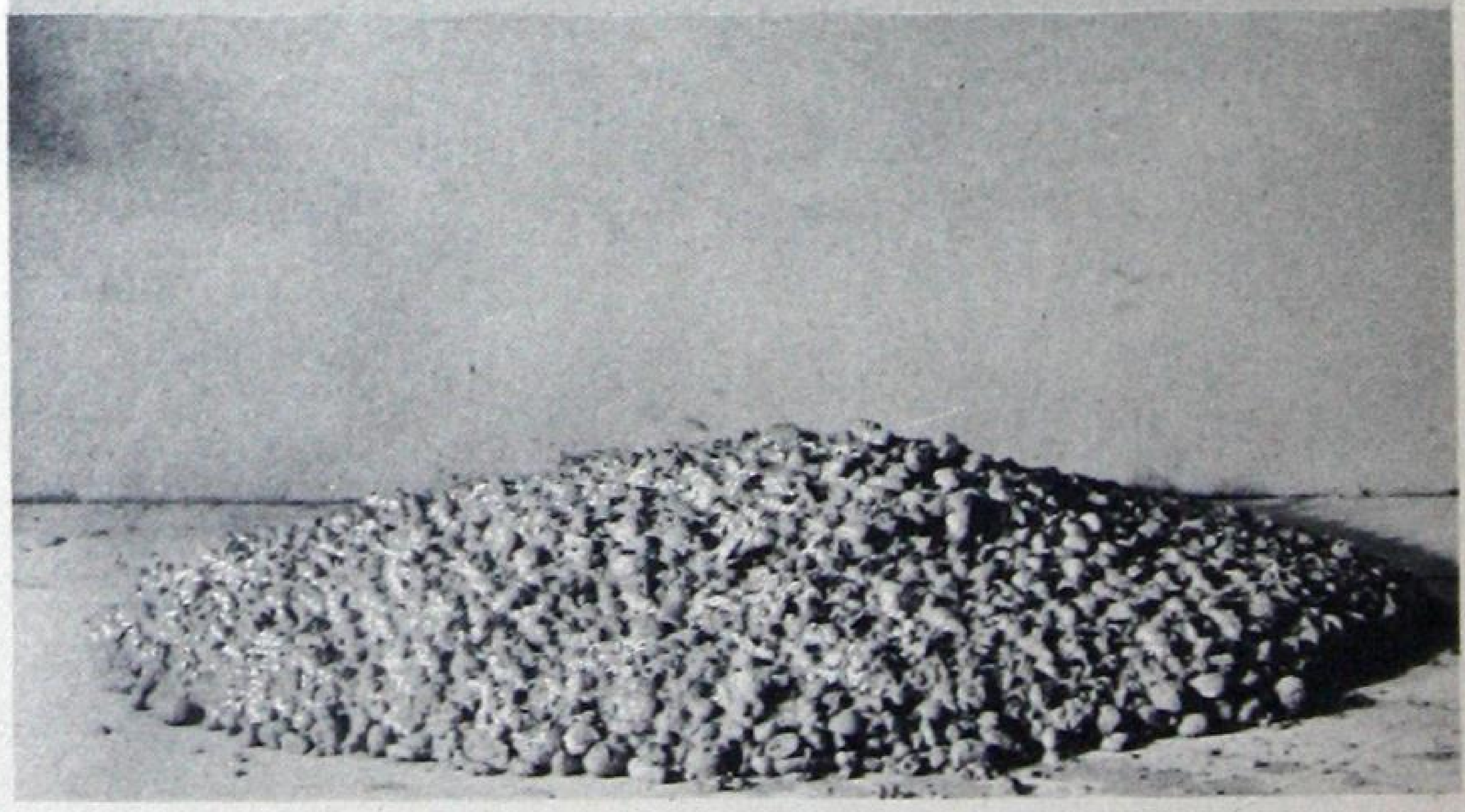


Fig. 6: Two photographs of the same batch of concrete show the effect of mixing time on consistency. Above, mixed 45 seconds; below, mixed 1½ minutes. Note how additional mixing improves workability. A poorly mixed concrete lacks uniformity, is harder to place, and will have less strength and watertightness.



Prevention of Segregation

Care must be exercised to see that the material is worked properly into the corners and angles of forms and around the reinforcement. Constant supervision is necessary to prevent the practice of depositing continuously at one point, requiring the material to flow to distant points. Concrete should be deposited as near to its final resting place as possible. (See Fig. 7).

An excessive amount of tamping or puddling in the forms will cause the materials to separate. Light spading of the concrete next to the forms will

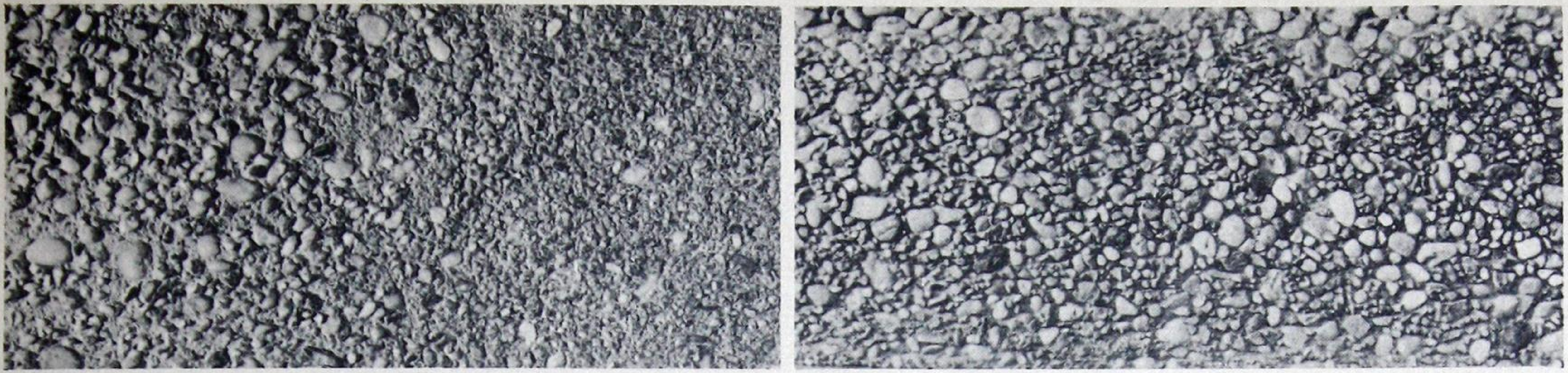


Fig. 7: Depositing concrete at one point and permitting it to flow in the forms requires a "soupy" mix. This results in segregation, and concrete lacks uniformity, as shown in the photograph at the left. Here concrete was deposited at the left side. Note how coarse aggregate settled near point of deposit, while the mortar flowed to other end of form. Now note the photograph at the right. This concrete was of medium consistency, contained the same amount of water, but about 25% more aggregate. It was placed at two points, nearer to the final resting place. Note equal distribution of coarse and fine aggregates. The concrete shown at the left is not only of poor quality but it was more expensive, because it was necessary to add another bag of cement per cu. yd. of concrete.

prevent honeycombing and make surface-finishing easier.

The ability of 'Incor' to hold a concrete together during handling is of genuine value. It insures a more uniform mass, free from honeycomb. Workmen are quick to note the superior workability of 'Incor' concrete and the greater ease with which it works into place.

In placing with a shovel, do not throw or scatter the concrete; turn the shovel over on depositing, or slide the shovel out from under the concrete.

Horizontal joints should be avoided. Concreting should continue without interruption until a complete unit has been placed. Where horizontal joints are unavoidable, the hardened concrete should be thoroughly cleaned and roughened if necessary. Before placing the fresh concrete, run a grout of moderately stiff mortar over the surface.

CURING

When concrete is mixed, a chemical reaction between the cement and the water begins. This continues only as long as the concrete is kept wet. The more complete and thorough this chemical reaction between cement and water, the greater the strength and watertightness of the concrete.

Some cements react slowly, 'Incor' combines rapidly with water. At the end of 48 hours, the chemical reaction of 'Incor' has advanced as far as ordinary cement at the end of 10 days. As a result, the thorough curing so essential for high strength, durability and watertightness is attained at least 8 days sooner with 'Incor'.

Concrete can be kept wet for only a short time,—forms must be removed, a floor placed in service. Because of its ability to cure thoroughly in two or three days 'Incor' concrete is strong and watertight. Ordinary concrete must be cured ten days to two weeks for similar results.

Methods of Curing

Wet burlap, canvas or straw covering should be placed as soon as possible without marring the surface of the concrete. Care should be taken to keep the covering continuously wet by frequent sprinkling. As soon as the concrete hardens, water should be applied liberally.

Ponding is an excellent method for curing flat, horizontal surfaces such as floors and pavements. With this method, the surface to be cured is surrounded with small earthen dikes and then kept flooded with water for the required period.

Vertical surfaces are more difficult to cure but the effort is well worth while. They may be protected by covering with canvas or burlap curtains, kept continuously wet with running water. Keep 'Incor' concrete wet for two or three days depending on the severity of the exposure—ordinary concrete ten days to two weeks.

Cold-Weather Concrete

In cold weather, it is important to heat the concrete and to protect it from freezing. After placing, it should be maintained at a temperature of 60° to 70°. 'Incor' concrete should be kept at these temperatures for 24 hours when temperatures are low but above freezing, two days between 32° and 20° and three days below 20°. For ordinary Portland cement these periods are three days, five days and ten days, respectively.

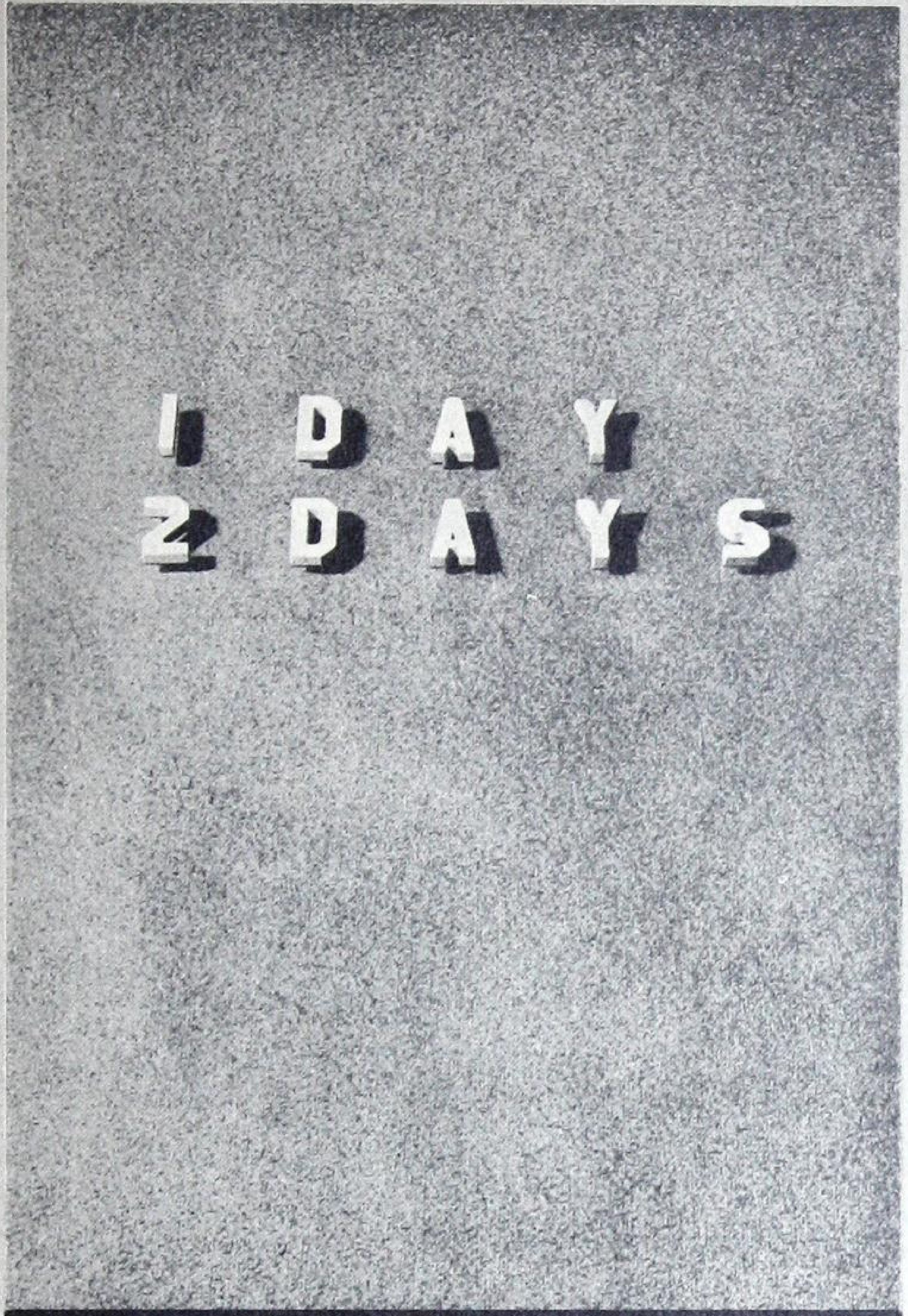
The range of winter work is greatly widened by the use of 'Incor' Cement, because it is only necessary to heat 'Incor' concrete and retain the heat for from one to three days, at the end of which time the concrete is ready to use. Risk of frost is minimized; substantial heating economies result; uninterrupted construction schedules are made possible.

QUICK SUMMARY

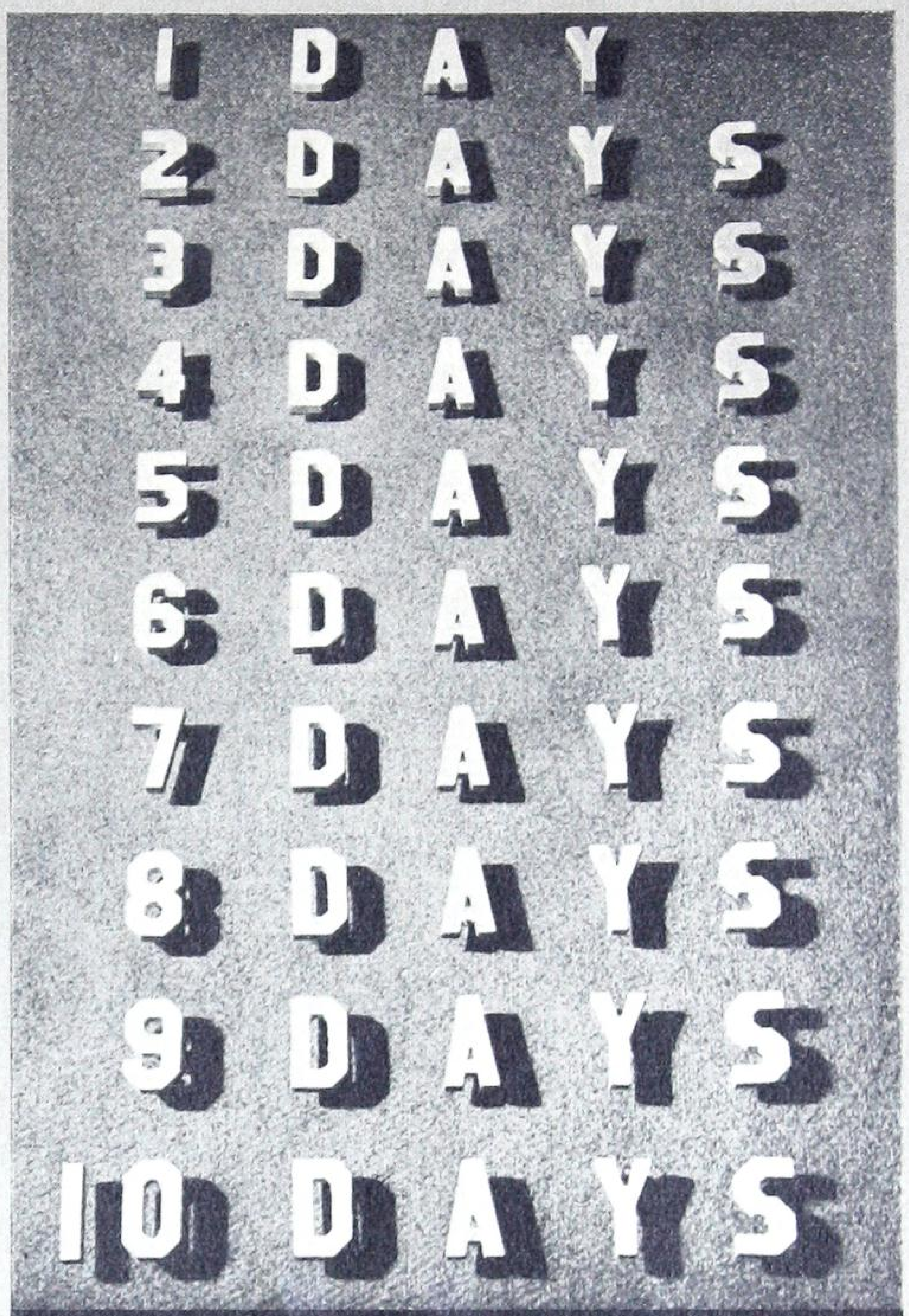
Essential steps in obtaining watertight concrete:

1. Determine water content from Table I (Page 4) and Fig. 1 (Page 5).
2. Select workability,—stiff, medium or soft,—to fit job requirements.
3. Determine approximate quantity of aggregate, with aid of Fig. 3 (Page 6).
4. Make trial batches, to determine proper proportion of sand.
5. For economy, use maximum quantity of aggregate (but be careful not to sacrifice workability).
6. Mix thoroughly, at least 1½ minutes after all materials are in mixer.
7. Deposit concrete without segregation.
8. Cure thoroughly; 2 or 3 days for 'Incor' . . . 10 days or 2 weeks with ordinary Portland cement.

WHY 'INCOR' MAKES BETTER CONCRETE



2 DAYS CURING WITH 'INCOR'



10 DAYS CURING WITH ORDINARY CEMENT

CONCRETE is watertight or not, depending on how well it is cured. Ten days curing under water, or equivalent, is necessary with ordinary Portland cement.

It is all very well to talk about ten days curing, but in practice concrete has to be used sooner than that,—and besides it costs money to cure concrete that long.

So it usually happens that concrete doesn't get enough curing.

'Incor' 24-Hour Cement assures stronger, more durable concrete, because it cures five times as fast as ordinary cement. In 48 hours 'Incor' cures as thoroughly as ordinary Portland cement in ten days. It is easy and inexpensive to cure concrete 48 hours,—but ten days is another story!

By curing thoroughly in the short time available under job conditions, 'Incor' makes better concrete.

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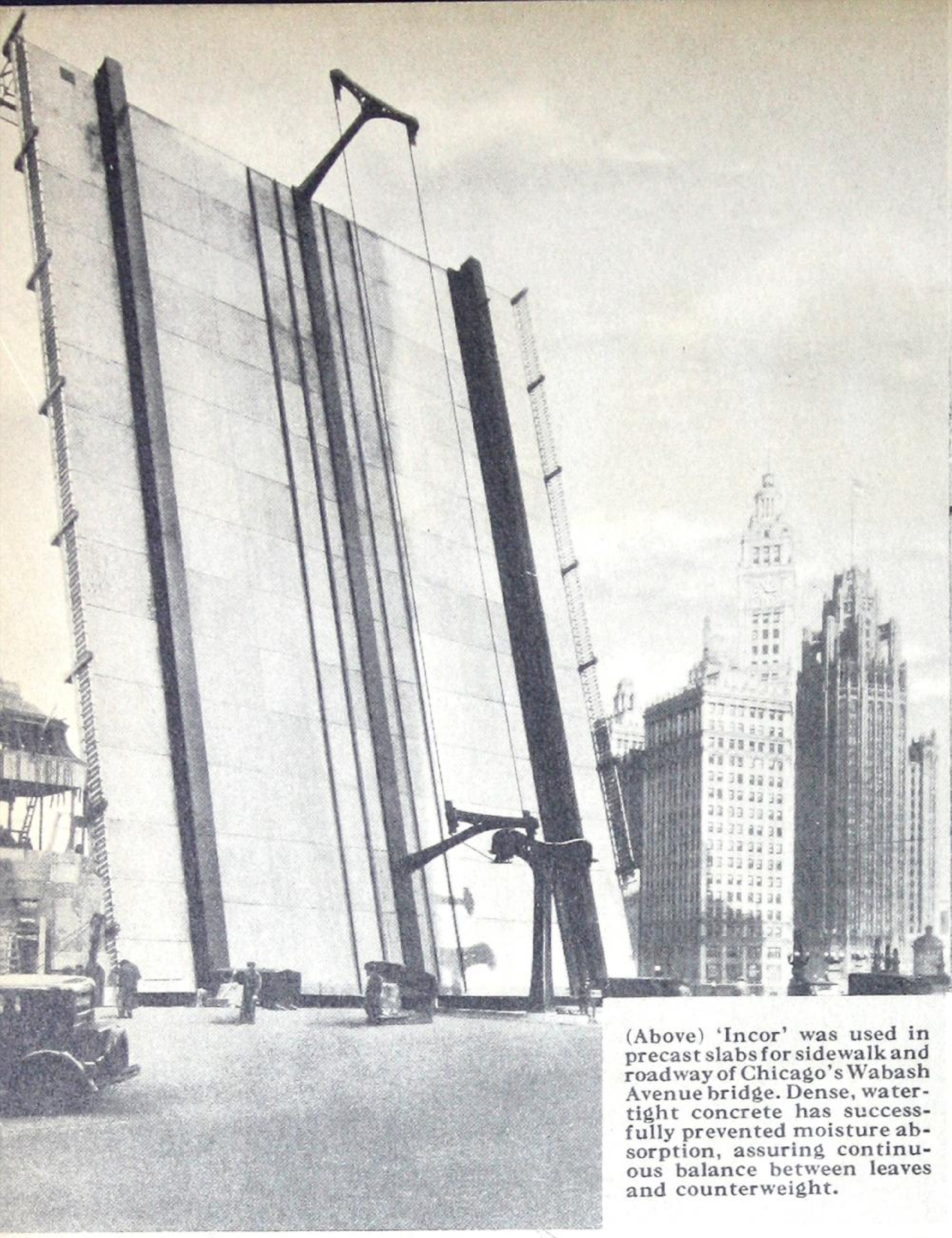
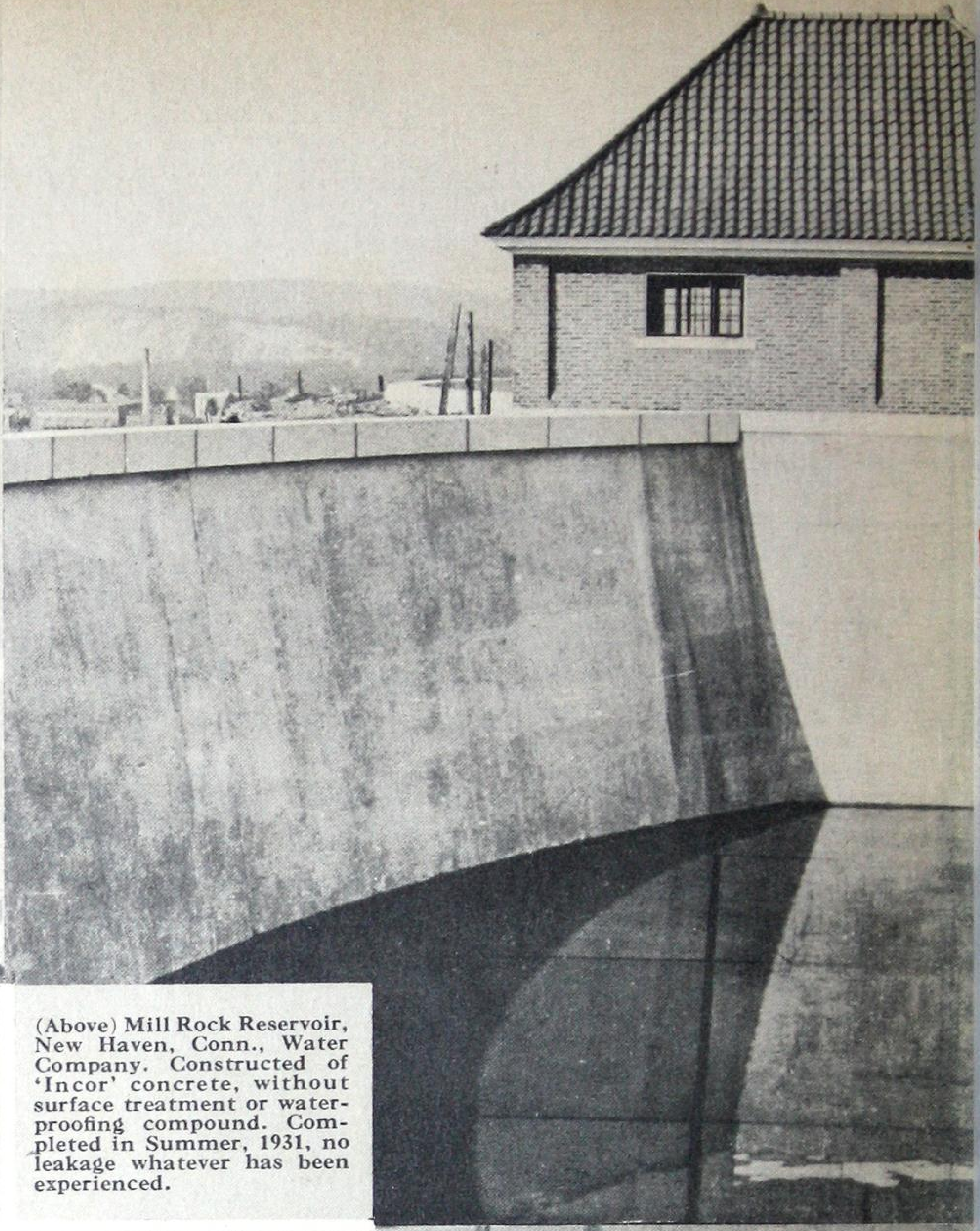


(Above) 'Incor' was used in precast slabs for sidewalk and roadway of Chicago's Wabash Avenue bridge. Dense, watertight concrete has successfully prevented moisture absorption, assuring continuous balance between leaves and counterweight.



(Above) Mill Rock Reservoir, New Haven, Conn., Water Company. Constructed of 'Incor' concrete, without surface treatment or waterproofing compound. Completed in Summer, 1931, no leakage whatever has been experienced.

(Below) Swimming pools require dense, watertight concrete. Engineers specified 'Incor' without admixtures for this Stamford, Conn., Yacht Club pool. Job was watertight, ready to use, 24 hours after last concrete was poured.

(Below) Constructed in mid-Winter with 'Incor' Cement, settling tanks for Cretona Print & Dye Works, Clifton, N. J., are giving thoroughly watertight service. Concrete heated to 60° produced 24-hour strengths equal to 7 days with ordinary cement.